THE WILDERNESS OF WORLDS

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A POPULAR SKETCH

—OF—

THE EVOLUTION OF MATTER

FROM NEBULA TO MAN AND RETURN.

THE LIFE-ORBIT OF A STAR.

BY

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PREFACE.

TRUTH courts light; but error shuns and deprecates impartial inquiry. The more difficult and important the question, the broader, freer, and more careful and thorough should be our study. The honest seeker after the truth gives all sides a hearing, and welcomes every addition to his mental equipment.

It cannot be denied that unbiased, intelligent judgment is extremely difficult of attainment. Our hereditary tendencies and early impressions are strong.

For forty years I have studied the subjects considered in this volume, and am to-day more than ever convinced that the legitimate domain of scientific investigation is as broad as the Universe,—and covers every thing that can be known.

I have in my mind a wilderness of trees. Those near me are of gigantic size; in the distance they seem smaller and smaller, fading gradually until the utmost limit of vision is reached. Not a single clearing is to be seen. The ground is covered with seeds, many of which are beginning to sprout. There are innumerable seedlings and young trees, and mature trees; all stages, the dying, the dead, and the prostrate, mouldering trunks,—a fair, a wonderful, but natural scene.

I raise my eyes and look outward into space. I see the wilderness of worlds. The one on which I stand seems of immense size. The innumerable multitude beyond fade in the distance. I run to the telescope; my vision is extended a thousand fold; millions more come into view, and in the thousand times more distant circle of vision fade gradually until in the outer limits only glimpses can be caught of faint points of light.

The worlds, too, are of all ages like the trees, and the great deep of space is strewn with their dust, and is pulsating with the potency of new births.

How grand, complete and sublime are the works and workings of nature. We stand with bowed heads, entranced and speechless in the presence of the Universe. Held in its all-embracing arms, we are of it,—one and inseparable.

G. W. MOREHOUSE.

Muskegon, Mich., 1898.

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TRUE FREEDOM.

"Is true Freedom but to break
Fetters for our own dear sake,
And, with leathern hearts, forget
That we owe mankind a debt?
No! true freedom is to share
All the chains our brothers wear,
And, with heart and hand, to be
Earnest to make others free!

They are slaves who fear to speak
For the fallen and the weak;
They are slaves who will not choose
Hatred, scoffing, and abuse,
Rather than in silence shrink
From the truth they needs must think;
They are slaves who dare not be
In the right with two or three."

—James Russell Lowell.

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CHAPTER I.

SPACE.

IF we would acquire a correct knowledge of any object it must be examined from more than one point of view. Close observation is required to study its structure, and a distant, general view to judge of its relative value. This principle holds good in the thorough investigation of any thing or any subject.

Watch the baby when he first begins to look around. He is a true scientist. He investigates and thinks at the same time, and his way is our way. He begins with no idea of distance, size, shape, or color. He does not know whether an object is within reach, or a rod, or a mile away. All must be learned. He patiently watches objects, especially those that move or are bright. If he can reach anything that attracts his attention, it is tested by touch and taste, and later by smell and sound. We are all growing and grown up children. If it is the truth we are seeking, their methods must remain through life our methods.

As with the individual, so with the human race, knowledge of the magnitude of space begins at zero and constantly widens during intellectual growth. The distance of objects in the room, the space in immediate reach, once learned cease to awe. Familiarity banishes

fear. As development goes on the circle of the known becomes larger, and the awful unknown beyond correspondingly less in extent and influence. As the dread of the unknown weighs less and less heavily upon us, the known becomes more enjoyable. This is substantially true from start to finish in the race of life. At first we are helpless, relying upon the protecting care of others in ways we do not understand. Our first efforts to help ourselves are blunderingly made and we come to grief. As we learn by experience we become more self-reliant and begin to lose our fear. We are long in learning to walk erect. So in the dim past, the human race has struggled almost hopelessly to get upon its feet. However, the horizon is widening.

There are always some men, who, actuated by the love of truth for its own sake, are forever prospecting along the borders of the unknown. The opinion of one such pioneer, as to the extent of space, should count for more than the notions of an army of men whose knowledge and experience is confined to their own township, county, state, or planet. On such a subject men would not be expected to go to school to ants, whose travels have extended over only a few square rods, and whose powers of vision and intellect are correspondingly limited.

Little value would attach to the belief of an animalcule to whom a pint of water is a world. Neither should the seeker for truth tie himself to the dead and comparatively ignorant past. The space required to contain the Universe is immeasurably beyond the grasp of the primitive or infant mind.

It would be a most egotistical and presumptuous toad, that, on jumping against a tight fence would assume that space in that direction ended there, and beyond the fence there could be absolutely nothing. Yet, such a concep-

tion would be nearly at par with the idea of space entertained by men who could believe the earth to be flat and resting on foundations. Embarrassing questions arose as to what lay beyond the edge, or beneath the foundations.

While men believed that the earth was the fixed center around which sun, moon and stars revolved, and the amazing distance of the stars was as yet unsuspected; space in the cosmical sense, could be conceived of as having a boundary. The distance away might not be so very remote. Everything was very dark to the human toad. He was intellectually caged.

The discovery by Copernicus that the Earth and the other planets revolved around the Sun, a body much larger than the Earth, and located at a vast distance therefrom, dissolved into nothingness the foundations, firmaments, crystal spheres, and all the metes and bounds of creation and space that had been so learnedly and laboriously dreamed out by the ancients.

The mathematical demonstrations of the distances of the celestial bodies, and the discovery and application of the telescope set the world thinking. Old beliefs had to be patched up and revised.

The space limits required indefinite extension to take in the new additions of Copernicus, Kepler, Galileo and Newton. The stars, already being mapped and catalogued, began to be measured and weighed. The way was opening for the study of their nature. Certainty was taking the place of child-like guesses. Elaborate philosophical theories fell before the newly discovered scientific facts. It is ever thus.

Ideas of the extent of the space in which we exist were rapidly enlarged. The eyes had before seen without understanding. They were now opened in a new sense. They were not only opened, but their visual powers were

greatly extended outward in every direction by the telescope. The new instrument gave distant vision,—a general panorama of the visible Universe. The invention of the compound microscope gave close vision. Space too small to be seen by the unaided eye, or too distant for its reach, was diligently searched. There began to be caught a glimmering of the overwhelming fact of the infinity of space.

The invention and perfecting of the achromatic refracting telescope followed, with the construction of large reflectors, with great light-collecting and space-penetrating powers. The bounds of the visible Universe were extended many-fold. Still no limit was reached. With our latest telescopes, with greatly increased light-collecting power, the same story is told. The old boundary has disappeared, and forever. The philosopher who reasons that if an imaginary limit to space in any direction is asserted, it may legitimately be asked, what lies beyond? has been justified by the results of the growth of astronomical science. However remote the limit may be fixed the question still applies. So to the philosopher and astronomer alike, space is without limit. The opposite proposition is evidently not rationally thinkable, any more than the boundary line-fence of the Universe is optically visible.

Words fail to convey to our minds an adequate idea of even the imperfect comprehension we may reach of the extent of infinite space. We use the words infinite, boundless, limitless, but to have them mean much to us it requires a strong mental effort, a long and wearisome journey on the swift wings of thought, straight outward into the immense known, and still onward into the vast realms of the unknown, Universe. Let us think!

CHAPTER II.

TIME.

THE next questions that naturally arise are: Did space have a beginning, and will it ever end?

The duration of time required for ordinary events is easily measured, using the rotation of our Earth on its axis, and its period of revolution around the Sun, for our units of measure. For smaller values we divide days into hours, hours into minutes, minutes into seconds, and in fractions of a second we may go down as far as the mind can conceive. A fraction of duration so infinitesimal as to be unnoticed by us would seem long to an insect whose life-history begins and ends the same day. A year would seem to it an incomprehensibly long period,—365 times its own average of life. For the man of seventy, this would be equivalent to 25,550 years. To what comprehension of the duration of human life could such a tiny, short lived creature, however intelligent, attain?

Every estimate of duration, as of other matters, is relative. To the child looking anticipatingly forward to manhood the years drag slowly along. The aged remember their life as a brief struggle,—a "fitful fever."

The historical period looks long to us when considering it only in the light of the multitude of notable events that have occurred. When we compare the figures it shrinks to a span. The ancient Hebrew books take us

back less than 6,000 years, the Chinese not much if any farther, and the Egyptians and other early traditions, ruins and tablets perhaps twice that time. All guide us along a very narrow and slippery trail.

The pre-historic age was much longer, as science has abundantly demonstrated. It was many thousands of years before man had become sufficiently advanced to perpetuate his achievements by picture inscription or writing. Knowledge which was gained by the individual could only be communicated orally, and handed down a few generations by tradition, became lost to the race.

Much that was written in the earlier records is of uncertain value because of the writers not having been themselves witnesses of the events they described. They quite generally had to depend upon tradition, or hearsay. Tradition was hearsay upon hearsay, and therefore the poorest of evidence.

It happens, then, that we possess no authentic written record of perhaps more than one-fiftieth of the time since mankind have inhabited the Earth. Geology, as will be mentioned in another chapter, brings to our knowledge a natural record, proving the Earth to be hundreds of millions of years old.

We have learned from astronomy considerable about the times before the Earth was inhabited, and even before it existed as a separate body.

If in this way we can get glimpses backward, say, 1,000,000,000 years, still the question as to what there was before is as pertinent as it would be were the time covered only a week. When seeking for the bounds of space we were lost in infinity ; so in like manner, we fail to find a beginning to time.

It is possible to judge something of the future fate of our race and our planet, for we can see and study, with

telescope and spectroscope, worlds more aged than ours, and therefore nearer the termination of world-life. This vision, fully as worthy of credit as any evidence relating to the past, carries us forward many millions of years in our estimate of future duration.

Go forward in imagination as far as this vast interval takes us, and from he new stand point take another look, and so on and on forever.

Space is infinite, and time is eternal. There could have been no beginning, and there can never be an end. To-day is as much a day of beginning, or of ending, as any other day that may be selected in the past or future.

Let us think about time, as we do about space, and study both together. There is an abundance of room and time for an exceedingly active Universe.

CHAPTER III.

MATTER.

BY the word matter we designate the substance that constitutes the world-building material of the Universe. It is evident to our senses, exists all about us, and in our own bodies. All are more or less familiar with its properties, and its wonderful combinations and varieties. Its usefulness and beauty are recognized and admired in the mineral, the vegetable, and the animal kingdoms. Volumes, yea, whole libraries would be inadequate to do justice to the grand subject. Anything like a systematic discussion of the well known properties and conditions of matter would not come within the scope of this volume. I can only indicate a few facts and conclusions with which we are at present most concerned.

Matter exists in at least three forms,—solid, liquid, and gaseous. Its solid form is due to the absence of heat, and on the application of heat it becomes liquid. A still higher temperature vaporizes. It then fills more space, but on cooling it resumes its original form and size.

Chemical action also changes the forms of matter, decomposing combinations and forming new ones, liberating the component gases of substances, and dissolving minerals or other solids or restoring them. The solid substance becomes an invisible gas, or the reverse. Colorless solutions when combined may produce beautifully

colored precipitates. It would be impossible to give much more than a hint of the varieties found in Nature.

Notwithstanding all the changes of form, and the many complex chemical combinations that matter has undergone in Nature, in the laboratory of the chemist, and in the seemingly destructive heat of the furnace, or of the Sun, not one particle has ever been destroyed. However changed it may have been, every ounce, and every grain and fraction of a grain, may be accounted for.

It has come to pass that the doctrine of the indestructibility of matter is established beyond a doubt. Matter may be divided and subdivided, and separated into microscopic particles and these into smaller molecules, and those again into indivisible atoms, thousands of times more minute than the molecules, yet, not one of the atoms can be destroyed. It takes its place again, and performs its part in the shifting scene of the Universe, in accordance with the economy of Nature.

Matter, then, being indestructible, its creation out of nothing becomes most emphatically unthinkable, and as a matter of course unbelievable. It has always existed and always will. Like time and space it is without beginning or end.

In olden times, along towards the infancy, or perhaps very early manhood of the race, when the germs of knowledge had not as yet begun to sprout, strange things were believed. One might harbor the notion that the strength of the belief was proportional to the unnaturalness of the then prevailing theories. Matter, all creation as known and believed in, was limited to small portions of south-western Asia, southern Europe, north-eastern Africa, a few islands, the surrounding ocean, the Black, Caspian, Mediterranean and Red seas, the clouds, the Sun, the Moon, and the stars "also." The wind was a

supernatural mystery. The Sun was a very small body, which like the Moon and stars, was made to give light for the Earth, and at night it withdrew behind the great northern mountains, to re-appear in the morning and continue its useful course. What little there was of the Earth was flat, or nearly so, rested on foundations, and was surrounded on all sides by an ocean, a border of mountains, and beyond them the jump-off. The sky, firmament, or heaven, made of crystal, and supporting the Sun, Moon, stars, gods and angels, rested securely on the surrounding mountains. Will any student of ancient history call this an exaggeration?

The art of printing with movable types was discovered as late as A. D. 1438. The first practical working steam engine was made in 1774, and steam navigation began with the present century. This century has also witnessed the invention of railroads, and the harnessing of electricity. The new astronomy, chemistry, geology, biology, etc., have been born, or which is much the same thing, had a new birth, since the discovery of America in 1492. If, then, such a large percentage of the most important advances in knowledge have been made so recently, we shall be warranted in giving little weight to ancient authorities. The respect due to age, or antiquity, should fall short of leading the immeasurably more competent living observer to wink at error, or to permit his judgment to be swerved in the least from the truth.

The modern observer, with new and improved instruments and methods, has perhaps reached his higher results, thus far, in the study of the nature and properties of matter, rather than in enlarging knowledge of its extent. This study necessarily embraces careful investigation of the manifestations of force that are always present.

Changes are everywhere taking place. The forces producing, accompanying, and resulting from these changes are found to be constant quantities. There is always an exact relation between the force exerted and the results attained. No power is ever gained or lost. It is found that energy, like matter, is incapable of being either created or destroyed.

As far as the telescope can penetrate space, matter exists. Every improvement in the instrument enables us to see clearer the stars already discovered, and brings to the eye faint glimpses of swarms still farther removed.

It is probable that the portion of the Universe, now visible from this planet, is less to what lies beyond our sight than is a grain of sand to the whole solar system.

We begin to realize the extent of matter. It, with its varying forms of energy, exists everywhere throughout boundless space,—"yesterday, to-day and forever." In extent and duration, that which is true of space and time, is also true of world-material and its inherent energy.

Examine a finely pulverized substance, for instance indigo, in a film of water, with a powerful microscope, and all the freely suspended particles are in constant motion. This is called the Brownian movement, for its discoverer, and it is also called molecular motion.

Matter, whether comminuted or in great masses, acts and is acted upon. Even the apparently solid and inert rock is permeated by unseen force. Remove the force that results in what we name—attraction of cohesion, and the rock would crumble into dust. Its integrity is maintained for a time against the assaults of the elements, because it is not devoid of sustaining forces. This is as true, if not as evident, as the display of magnetic power by the loadstone.

Inertia of matter is a term only to be properly used in the restricted, mechanical sense. Receptivity and activity are present in every particle of the material of the Universe.

Can matter thus active be properly called dead? Let us revise our inherited and crude notions, and fearlessly acknowledge that such an anomaly as dead matter does not exist. The moment the vital forces cease to act in the living organism, decomposition into the original elements begins. This is chemical action. It is not a cessation, but a change of activity.

Perhaps, then, it might be better to call it living matter, even if it be necessary to add to the elasticity of the word *living*, to make it fit the idea.

CHAPTER IV.

DISTRIBUTION OF MATTER.

THE distribution of matter in space is by no means uniform. That fact might be suspected from the different apparent magnitudes of the stars. This appearance being found not to be entirely due to differences in distances, or in intensity of light, the suspicion becomes a certainty. In our planetary system no two bodies are of the same size. Looking out upon the stars we see them grouped irregularly. Some portions of the heavens are exceedingly rich in stars, while others are very poor. This is also the case with telescopic stars.

There is want of uniformity everywhere. This is as true of the stars in the heavens as of the trees in a forest, or the stones in a field. This fact is eminently characteristic of the works of nature. The celestial bodies are as diverse in density as they are irregular in distribution.

They are scattered as lavishly and wastefully as are pollen grains, or the grains of sand on the shores of the ocean. Nature, with infinite resources, can well afford to be prodigal, even of worlds.

If the word prodigality may be used in regard to the number of the stars, what can be said of the immensity of the surrounding space. This space is also occupied. It is probably filled throughout with an exceedingly rare me-

dium. Aside from planets, it is known to contain innumerable bodies smaller than the stars, and revolving around them. Such bodies fall upon the earth continually in the form of meteoric stones and meteoric dust.

Notwithstanding the irregularity of the distribution of cosmical matter, there is no evidence of its not being everywhere in great profusion. In regions of space that appear comparatively empty there may be the average quantity of matter. It may be present in numerous bodies too small to be seen, or in larger dark ones. We have very good reasons to suspect the presence of dark bodies of no inconsiderable size in the starry realms. I shall doubtless have occasion later in this work to refer to them more at length.

The masses of matter that we call fixed stars are distributed at great distances from us and from each other. Relatively few can be said to be comparatively close. Most of them are sparse compared with the space occupied. The fact that these distances are indeed enormous is capable of accurate and unquestioned proof.

A surveyor, wishing to measure the distance across a stream, can do so without crossing if he has an instrument adapted to the purpose. He measures a base line along the bank, and takes observations from each end of the line, of some object across the stream, measuring the angles. He then has a triangle with a known base line and two known angles, the other lines meeting at the apex across the stream. The calculation of the distance, from the data thus obtained, is a simple problem in plain trigonometry, and the width of the stream is accurately determined.

In like manner, observations of the Sun, Moon, or planets may be made, and angles measured from two distant positions on the Earth, giving a known base line.

Then, if the measurement be exact, the distance can be computed.

The different positions on the Sun's disk of the planet Venus, when in transit, as viewed at the same instant from points widely separated, gives the ground for a good method of computing the distance of the Sun.

Observations may be taken on a fixed star, six months apart, using in this case the whole diameter of the Earth's orbit for a base line, when, if the star shows a measurable parallax, its distance may be determined.

So it is seen that the distances of the celestial objects are ascertained with mathematical accuracy, subject only to errors of measurement of parallax. Their distances being approximately known, a correct idea can be got of the actual sizes of those near enough to have measurable disks, and a valuable rough guess on many others.

It is very evident that if all the matter contained in the region within our range of vision was distributed uniformly, there being no stars or other condensed bodies, this homogeneous substance would be exceedingly rare. Doubtless it would be more attenuated than the lightest known gases. This primary matter, if at rest, would be invisible. In this homogeneous, inert state, universal energy might be imagined as lying dormant, awaiting some outside creative impulse. This impulse once given, the known laws governing the attraction and condensation of matter, would in the course of time transform portions of the invisible material into tangible worlds.

If such a condition of uniformity, and absolute rest, ever obtained, which is more than doubtful, it long since came to an end. Now, there are no known exceptions to the universal rule,—of motion, variety and change. The distribution of matter in space could scarcely be imagin-

ed to be more diversified. Any seeming sameness is dispelled by closer and more careful scrutiny.

The spectroscope has given the study of the character and distribution of matter a new impulse. Elements familiar to us as constituents of our earth are found to be present in the celestial bodies. In the most remote starry regions, not only are the elements found, but their conditions are determined. The instrument enables us to judge in a general way of their temperature. It may not be out of place to briefly explain the construction and working principles of this wonderful instrument, to further prove upon what solid foundations the new science rests.

A glass prism refracts and disperses light. The colored image produced is called a spectrum. The prism separates the colors because each color has a different wave length. The length of wave is the measure of energy. The spectrum divides into the seven primary colors, red, orange, yellow, green, blue, indigo and violet,—always arranged in the same order. Besides the colored light waves that are thus visible, there are many more beyond the red at one end of the spectrum, and the violet at the other. The length of this invisible spectrum greatly exceeds that of the visible. These rays to which the retina remains insensible are analogous to those that are visible, and produce powerful chemical and thermal effects. They indicate the heat energy and chemical nature of the Sun or other luminous bodies from which they emanate.

In the spectroscope several prisms are generally added to increase the dispersion, or diffraction-grating may be used instead of prisms to produce the desired effect. To cut off diffused light, and make the image more distinct, the light to be examined is admitted through a narrow slit. A lens behind the slit renders the rays parallel as